Space Weather Technical Forecast

Issued on Wednesday, 16 February 2022 at 12:53 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of Minor R1 Radio Blackouts. Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours, with an M1.3 flare observed at 15/1815 UTC from the largest and most magnetically complex region currently on the visible disc, AR2941, which is near the western limb. This was a long duration M-class flare, although no Coronal Mass Ejection (CME) was evident in the imagery from this event. Given its location any CME would unlikely have been Earth-directed. There are currently seven Active Regions on the visible disc, though three of the regions remain unnumbered. The largest is the aforementioned AR2941, which is classified as a Eki/Beta-Gamma configuration, although given its location, its becoming difficult to assess its classification due to the foreshortening effect. The remaining sunspots on the disc are all relatively small and stable, although a new region in the northern hemisphere, which is currently unnumbered, shows a Bxo/Beta-Gamma configuration, which will be monitored for any further developments. An impressive far-sided CME was observed in cororagraph imagery at 15/2212UTC, although this is not Earth-directed. No Earth-directed CMEs were in evidence in available coronagraph imagery.

Solar Wind / Geomagnetic Activity: Earth has recently exited from a high speed stream (HSS) from coronal hole 53 (no longer visible on disc), with solar wind speed, as measured by DSCOVR at L1, starting the period at slightly elevated levels, at around 415km/s, with a gradual decline to background levels, currently at around 360km/s.The solar wind density has been average to below average. The IMF was weak, peaking at 6nT, while the north-south component ranged from +3 to -4nT. The phi angle, meanwhile was predominantly negative (towards the sun).The net result of the above solar wind measures was Quiet (Kp0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV) was at High levels throughout, peaking at 7940pfu at 15/1645 UTC. The corresponding 24-hour integrated electron fluence was above the 1e8 Active level throughout, with a rising then steady trend observed, that finished the period at 15/2359UTC with 3.72e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to carry a daily Chance (30%) of M-class flares - these most likely from AR2941 until day 2 (17 Feb), at which point this risk should fall, with activity becoming Low or Very Low throughout the remainder of the forecast period. Further sunspots are likely to rotate onto the disk through the period and these will be monitored for development and flare potential.

Solar Wind / Geomagnetic Activity: No CMEs feature in this forecast period. The recent high

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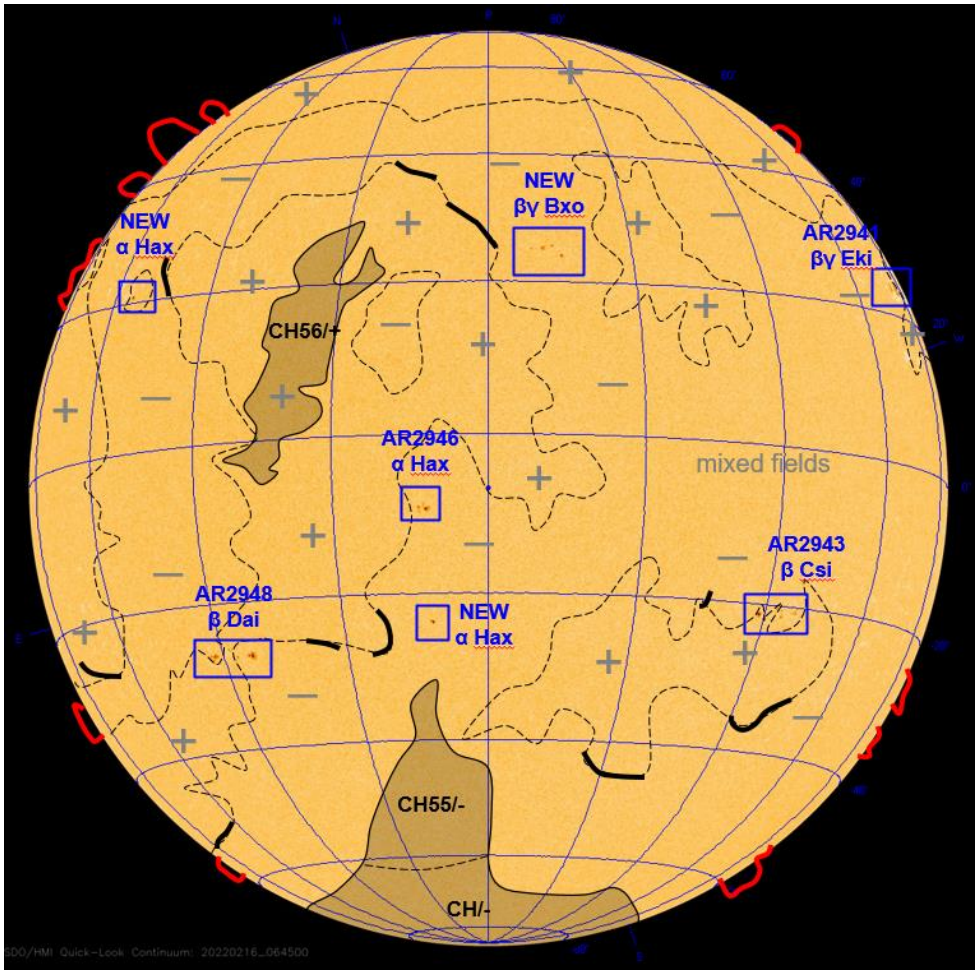
speed stream from coronal hole 53 is waning. Geomagnetic activity is likely to remain Quiet throughout the period.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with a daily Slight Chance of S1, mainly up to day 2 (17 Feb) while AR2941 remains near the western limb.
The high energy electron flux is expected to continue in its current mainly High flux diurnal oscillation - in the absence of any further drivers of increased geomagnetism. Active (1e8 integrated pfu) electron fluence levels are expected each day, perhaps with a slight waning trend as the ambient environment proves less supportive of maintaining current levels with time.

Figure 1. Solar Analysis Valid 16/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs feature in this forecast at present, however confidence in this is somewhat lower than usual given numerous (particularly westward-directed) CMEs observed around the very end of the last week. Imagery from the C1.3 flare didn't show any evidence of a CME. However, given its location, AR2941, suggests any CME would have been unlikely to be Earth-directed.
The High Speed Stream from CH53 is waning, and no further coronal holes are expected over the next 4 days. Solar winds are likely to remain at background levels. Geomagnetic activity is expected to be mostly Quiet throughout the four day period. This forecast is reflected in both persistence, the appearance of the current disc (i.e. the absence of notable central coronal holes) and also unremarkable recent STEREO A measurements.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: An impressive far-sided CME observed in STEREO-A (left) and LASCO-C3 (right) although the CME is not Earth-directed.

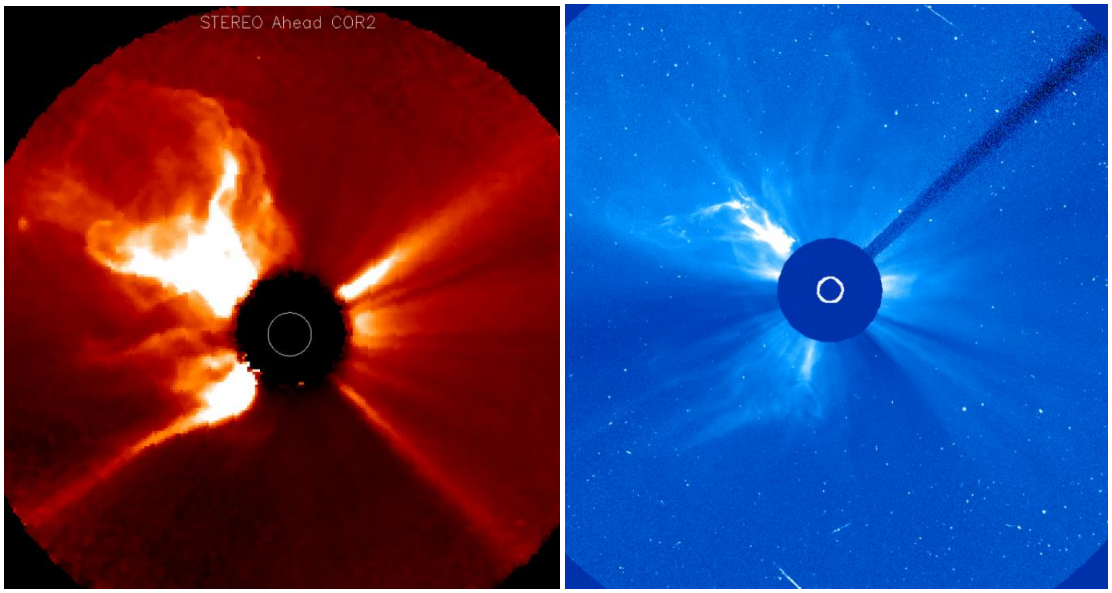

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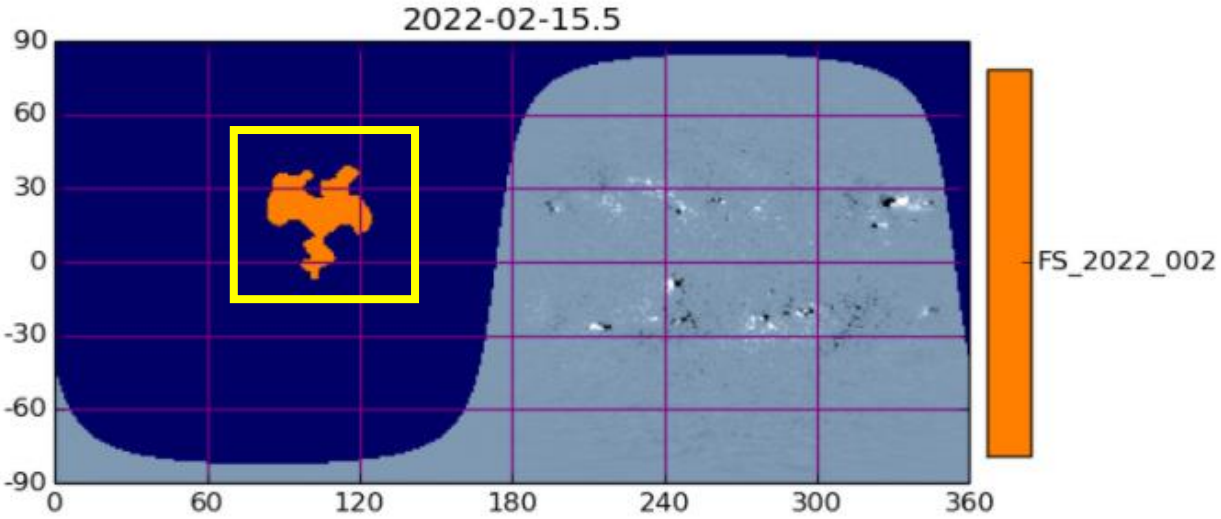
Figure 3: Stanford Seismic Monitor of the Sun's far-side hemisphere, which shows bright orange region (inset of yellow square) as likely source for the far-side CME seen in imagery above.



Radio Blackouts - X-Ray Flares:

The balance of sunspot groups should enter a state of flux over the forecast period. AR2941 is expected to rotate off the visible disc, though the flare risk remains significant into day 2 (17th Feb). Further regions are expected to rotate onto the eastern limb, with further regions potentially developing within the visible disc. There are three NEW regions in the visible disc, which are currently unnumbered, although one region in the northern hemisphere is showing a Beta-Gamma configuration, which will continue to be monitored for further developed and potential flare risk.

The X-ray forecast on balance starts with a daily Chance of M-class flares, reducing to a Slight Chance by day 3 (18th), however this may be revised further downwards should the eastern horizon spots fall short of expectations as the western limb quietens down.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	20	15	5
Very Active	R3 to R5 X Class	No	2	2	1	1

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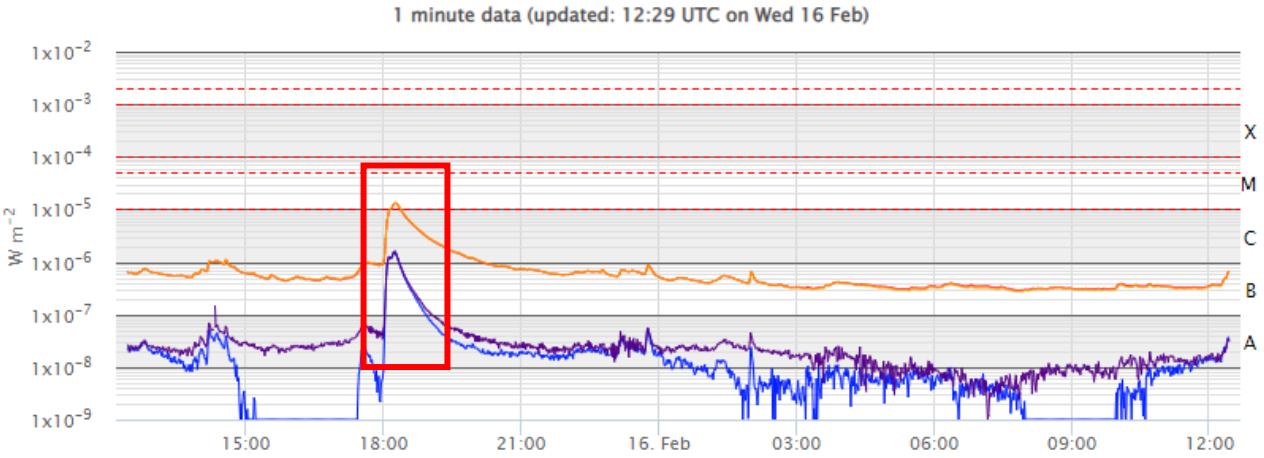
Figure 4: GOES X-Ray flares, which shows the M1.3 flare at 15/1815UTC from AR2941.

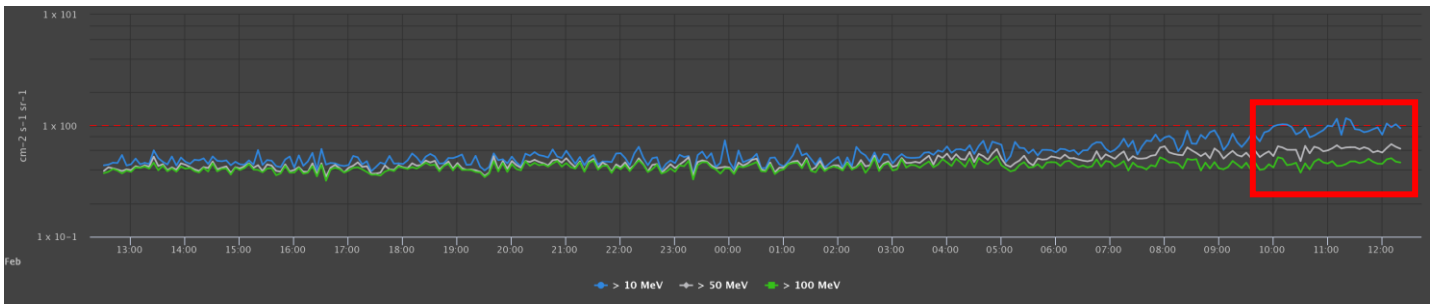


Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels.
Solar radiation storms are not expected in the period, however there is a very slight chance for proton fluxes to rise given any significant flaring from regions close to the western limb, mainly up to day 2 (17 Feb) while AR2941 remains close to the west limb.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	2	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-16 Proton Flux – slight enhancement above background levels of the >10 MeV, but remained below the threshold. Enhancement is likely due to the impressive far-sided CME mentioned above.



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High Energy Electrons Event (≥ 2MeV):

Earth remains under the waning influence of CH53/-, with high energy electrons now having responded by rising to a mostly High flux diurnal oscillation. In the absence of any further impetus in the four-day period, current levels should be maintained initially, but with increasing uncertainty with time and perhaps a gradual decline.

Current levels are proving similar to the last rotation, where the Active 24-hour integrated fluence threshold was marginally exceeded each day. This gives us greater than usual confidence that Active fluence levels are expected in the four-day period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	70	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: GOES-16 Electron Flux – remain at high levels in the diurnal oscillation.

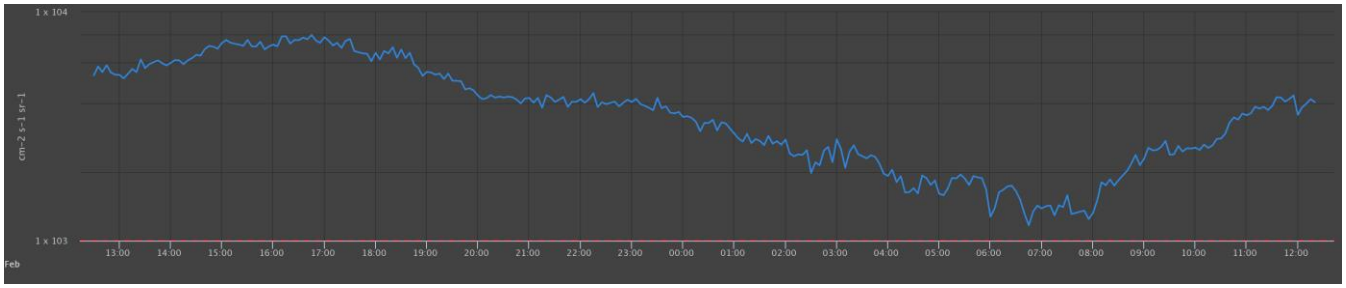
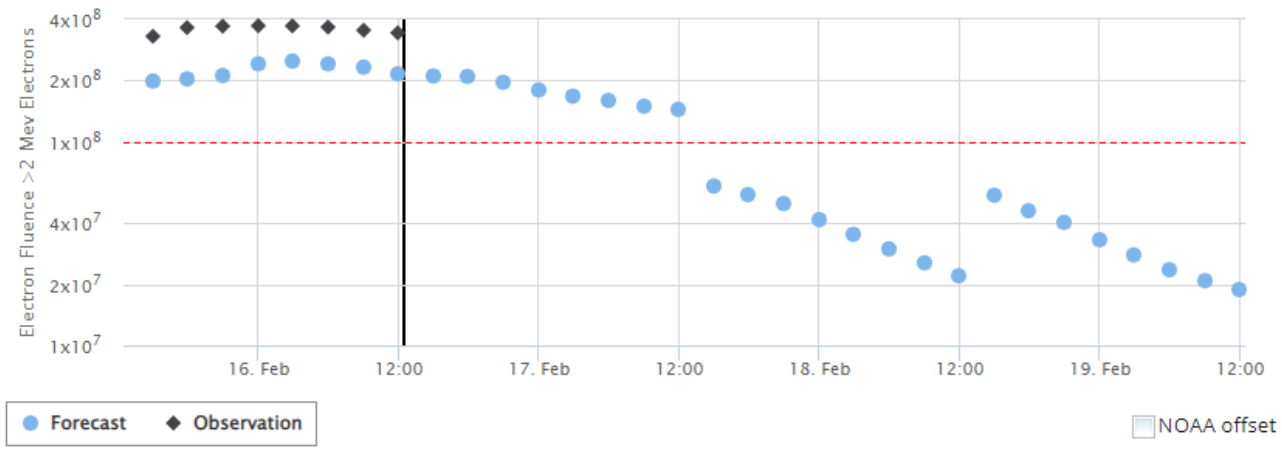


Figure 7: REFM electron fluence observed and forecast – currently exceeded the >2Mev threshold, similar to the previous rotation.



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